ACI Research Paper #17-2025

Singapore's Innovation Landscape: The Role of Cross-Border Collaboration with the US in the post-USSFTA Era

Thi Hang BANH

Yixuan GE

December 2025

Please cite this article as:

Banh, Thi Hang, and Yixuan Ge, "Singapore's Innovation Landscape: The Role of Cross-Border Collaboration with the US in the post-USSFTA Era", Research Paper #17-2025, *Asia Competitiveness Institute Research Paper Series (December 2025)*.

Singapore's Innovation Landscape: The Role of Cross-Border Collaboration with the US in the post-USSFTA Era

Banh Thi Hang[1] Ge Yixuan

Abstract:

This paper investigates the evolving innovation relationship between the United States (US) and Singapore, focusing on patent-based indicators of collaboration in the post–US – Singapore Free Trade Agreement (USSFTA) era. The USSFTA, implemented in 2004, embedded "TRIPS-plus" intellectual property (IP) standards – including patent term extensions, pharmaceutical data exclusivity, and stronger enforcement – that reshaped Singapore's IP regime and reinforced its credibility as a trusted hub for high-value research and development (R&D). Using patent data from the European Patent Office's PATSTAT database, the study traces trends in Singapore's innovation landscape, examining patenting volume and origin, sectoral specialization, and the internationalization of co-invention. The findings reveal a dynamic transformation in Singapore's innovation ecosystem, characterized by rapid growth in patenting activity and a clear orientation toward high-value sectors such as semiconductors, electrical engineering, biotechnology, artificial intelligence, clean technologies, and quantum technologies. Collaboration with the US has not only intensified but also diversified beyond its traditional concentration in electronics. While US firms continue to dominate ownership of jointly developed inventions, Singapore has broadened its innovation partnerships with China, Japan, and other Asian economies, enhancing resilience in a multipolar innovation landscape. Cross-border activity remains heavily driven by multinational corporations, but universities and research institutes also play an important complementary role. Overall, the analysis underscores how trade agreements, IP reforms, and cross-border collaboration interact to shape national innovation systems. For Singapore, the USSFTA provided both the institutional foundation for its IP regime and the anchor for its integration into US-led – and increasingly global – innovation networks.

[1] Banh Thi Hang (email: hangbanh@nus.edu.sg) is a Research Fellow at the Asia Competitiveness Institute, Lee Kuan Yew School of Public Policy, National University of Singapore

1. Introduction

Singapore's rise as a global innovation hub is inseparable from its international economic strategy. Since the late 20th century, the city-state has pursued a model of growth that hinges on openness, foreign investment, and integration into global value chains. Yet what distinguishes Singapore from many of its regional peers is the way it has leveraged international trade agreements – particularly with the United States – to embed high standards in its domestic institutions and to secure credibility as a trusted environment for knowledge-intensive activities.

The USSFTA, implemented in 2004, marked a decisive step in this process. Beyond liberalizing trade and investment flows, the USSFTA introduced far-reaching reforms to Singapore's intellectual property regime, embedding "TRIPS-plus" [2] provisions such as patent term extensions, pharmaceutical data exclusivity, and stronger enforcement mechanisms. These reforms reassured US multinationals of the security of their intangible assets and established Singapore as a reliable jurisdiction for high-value research and development. At the same time, they strengthened bilateral innovation linkages, embedding Singapore into US-led knowledge networks and anchoring its transition from manufacturing to an innovation-driven economy.

The United States has played a foundational role in shaping Singapore's innovation landscape. US firms in electronics, pharmaceuticals, and information technology were among the first to anchor their regional R&D and IP activities in Singapore, transferring technological know-how and embedding the country in global supply chains. More recently, collaborative initiatives such as IBM Studios Singapore, the PayPal Innovation Lab, and JLABS – launched through a partnership between Johnson & Johnson Innovation and Singapore's Economic Development Board – illustrate how American corporations continue to drive frontier innovation activities in Singapore. In parallel, bilateral initiatives like the Partnership for Growth and Innovation (PGI, 2021) and the Critical and Emerging Technology (CET) Dialogue (2023) underscore the commitment of both governments to deepening cooperation in emerging technologies.

While the USSFTA has been analyzed as a landmark in Singapore's trade diplomacy and IP modernization (Ng-Loy, 2004; Gill et al., 2014), less attention has been paid to its long-term

[2] TRIPS stands for World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights

implications for innovation collaboration. In particular, the post-USSFTA era offers a unique opportunity to analyze how institutional reforms and policy alignment have shaped the trajectory of cross-border research and patenting activity, especially with the United States. Patent data offer a valuable lens for this analysis, revealing not only the scale and direction of collaboration but also sectoral and technological shifts in co-invention.

This paper seeks to analyze the bilateral innovation dynamics between the US and Singapore following the implementation of the USSFTA, with a particular focus on patent-related activities as measurable outcomes of innovation collaboration. Leveraging data from the PATSTAT database published by the European Patent Office, which includes comprehensive bibliographic, citation, and patent classification information from over 100 million patents across more than 100 patent offices globally, this study examines key sectors and technologies driving collaborative patent activities between the two nations.

Key findings from this study reveal a dynamic transformation in the innovation landscape between the United States and Singapore. Singapore has demonstrated rapid growth in patent applications per capita. This impressive rise reflects Singapore's deliberate strategy to position itself as a leading global innovation hub and signals a successful evolution in its national innovation capacity.

The partnership between the US and Singapore has also strengthened considerably, particularly in the form of co-invention and co-application activities. These collaborative efforts have intensified in recent years, with the two countries increasingly joining forces in advanced sectors such as semiconductors, electrical engineering, and – more recently – artificial intelligence. Notably, the early years of collaboration were heavily concentrated in semiconductors and electronics, but recent data reveal a clear diversification into other high-value areas including biotechnology, clean technology, quantum technology, and AI. This shift demonstrates both countries' ability to adapt to and lead in emerging technological frontiers.

The private sector remains the primary driver of innovation collaboration, with companies accounting for the largest share of jointly held patents. However, universities and research institutes are also essential contributors, underscoring the importance of a vibrant ecosystem that leverages strengths across industry and academia.

Another important trend is the growing internationalization of innovation networks. While the US remains Singapore's primary collaborator, Singapore's innovation partnerships have diversified significantly over the past decade, engaging an expanding range of global partners. This broadening of international collaboration reflects the increasingly complex and interconnected nature of modern R&D ecosystems.

The rest of the paper is organized as follows. Section 2 reviews the USSFTA's intellectual property provisions and their implications for Singapore's innovation system. Section 3 describes the data used. Section 4 provides an overview of Singapore's innovation landscape. Section 5 explores the innovation collaboration activities between the two countries. Finally, Section 6 concludes.

2. The role of the USSFTA's IP provisions

The USSFTA marked a watershed moment in Singapore's intellectual property regime. For Singapore, a country transitioning from a manufacturing hub into a knowledge-driven economy, the USSFTA's IP chapter served as both a benchmark and catalyst for systemic reform. While Singapore had already modernized its IP laws to comply with the World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), the USSFTA introduced "TRIPS-plus" standards that elevated protection and enforcement mechanisms beyond the multilateral baseline (Gill et al., 2014; Chiu, 2004).

The USSFTA introduced stronger protections in several areas, including longer copyright terms, enhanced data exclusivity for pharmaceuticals, stricter limitations on compulsory licensing, and more robust enforcement obligations. These provisions aligned Singapore's IP regime with US standards, described at the time as "state of the art protections for Internet commerce and intellectual property" (Ng-Loy, 2004). Crucially, these measures reduced the legal uncertainties that foreign firms – especially from knowledge-intensive sectors such as biotechnology, pharmaceuticals, and software – faced when investing in Singapore.

Perhaps the most significant USSFTA innovations came in the area of patent protection. The agreement committed Singapore to extend patent terms to compensate for unreasonable delays in patent examination or regulatory approval – a move designed to ensure that rightsholders could fully enjoy the 20-year period of exclusivity promised under TRIPS. For the pharmaceutical sector, the USSFTA went further by introducing data exclusivity provisions

that prevent generic manufacturers from relying on clinical test data submitted by originators for at least five years (Ng-Loy, 2015). Additionally, the agreement curtailed the flexibilities available under TRIPS by narrowing the scope for compulsory licensing and restricting parallel importation of patented pharmaceuticals (Ng-Loy, 2004).

These measures directly addressed long-standing US concerns about inadequate protection for pharmaceutical and biotech patents abroad, while also serving Singapore's ambition to attract investment from high-value life sciences firms. For local stakeholders, however, the impact was double-edged: while stronger patent rules bolstered Singapore's reputation as a biomedical hub, they also delayed the entry of generics, raising concerns about healthcare affordability. Although it is difficult to empirically link stronger patents to immediate growth in IP-intensive sectors, such provisions undoubtedly aligned Singapore with global leaders in pharmaceutical IP protection and enhanced its credibility as a partner in cross-border R&D collaboration (Ng-Loy, 2015).

The USSFTA's IP provisions also exerted a "template effect" on Singapore's subsequent free trade agreements. As Ng-Loy observes, Singapore's acceptance of TRIPS-plus obligations in its deal with the US normalized a higher baseline of IP protection that later appeared, in varying degrees, in agreements with Australia, Japan, Korea, and eventually in broader regional frameworks such as the Trans-Pacific Strategic Economic Partnership and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) (Ng-Loy, 2015).

By committing to such high-standard IP rules, Singapore signalled to global investors – particularly US firms – that it could provide a reliable and secure environment for managing and commercializing intangible assets. This credibility was crucial at a time when Singapore was seeking to transition from a manufacturing-led economy to a knowledge- and innovation-driven system. The agreement thus reassured multinational corporations that their R&D investments and intellectual property would be well protected, positioning Singapore as a natural base for global and regional innovation activities. This strategy also differentiated Singapore from its ASEAN neighbors, many of whom remained hesitant to commit to stringent IP obligations, thereby giving Singapore a competitive advantage as a regional hub for high-value industries (Gill et al. 2014).

The strengthening of IP protection through the USSFTA also had domestic implications. It spurred institutional development, notably the role of the Intellectual Property Office of

Singapore (IPOS), in fostering an environment where both foreign and local innovators could thrive. While empirical links between TRIPS-plus protection and growth in IP-reliant sectors remain difficult to isolate (Ng-Loy, 2015), the USSFTA undeniably reinforced Singapore's long-term strategy: to move up the value chain, attract innovation-driven investment, and transform itself from an importer to a producer and exporter of intellectual property.

The immediate outcome was a surge in patenting activity, particularly in fields dominated by US multinationals such as semiconductors, pharmaceuticals, and ICT. More broadly, the agreement anchored Singapore within US-led innovation networks, enabling local inventors and institutions to tap into advanced knowledge flows, global commercialization channels, and collaborative research opportunities. Over time, these connections helped Singapore expand into new frontier technologies, from biotechnology to artificial intelligence, while sustaining its competitiveness in established sectors.

In this sense, the USSFTA was more than a trade agreement. Its IP provisions were not simply technical adjustments to Singapore's legal framework, but a strategic lever that embedded the city-state in global innovation networks, elevated its trade diplomacy, and underpinned its domestic transformation into an innovation-driven economy. These reforms laid the foundation for Singapore's subsequent cross-border collaborations with the United States and beyond, making them central to understanding its post-USSFTA innovation trajectory.

3. Data sources and definition

3.1. Data sources

To examine the collaborative innovation activities between the US and Singapore following the implementation of the USSFTA, we utilize the PATSTAT database. Maintained by the European Patent Office (EPO), PATSTAT is a comprehensive and widely used global patent database designed for patent analytics and statistical research. It covers bibliographic data on patents from over 100 patent offices worldwide, including detailed information on patent applications, publications, legal status, citations, and family relationships.

Considering the availability of data, we used the Autumn 2022 version of PATSTAT, and we have imputed missing information in the original database, such as the person country code for inventors and applicants, as well as the technical field of the patents. For detailed imputation methods, please refer to Ge et al. (2022).

3.2. Key definitions

In analyzing patent data from the PATSTAT database, key terminologies used throughout this study are defined as follows:

- Inventor: The individual or team who originated and developed the inventive concept detailed in the patent. Inventors are explicitly named in patent documents and their identities are tracked within the PATSTAT database.
- Applicant: The entity – whether an individual, company, university, or other organization – that formally files the patent application. While the inventor and applicant may coincide, an applicant often represents a corporate entity or institution that has acquired, via assignment or contractual agreement, the rights to the invention. PATSTAT clearly differentiates applicants from inventors in its data structure.
- Origin: The geographical source or the country associated with the inventor or applicant. Within PATSTAT, the origin is represented by a standardized country code. It is important to note that the country code reflects the location of the inventor or applicant, but does not necessarily correspond to their nationality.
- Destination: This refers to the patent office or jurisdiction where the patent application is filed and processed. PATSTAT database specifies the destination by using patent office codes, indicating the specific location where intellectual property rights are sought.
- Patent Family: Defined as a set of related patents filed in multiple jurisdictions, which cover the same or similar technological content. PATSTAT provides comprehensive data on patent families, facilitating analyses of international protection strategies and global intellectual property coverage for inventions. Patents examined in this study are grouped at the family-level, meaning identical patents filed across different patent offices are considered collectively.

Although different patent offices have varying procedures and requirements for patent applications, the process generally involves several key stages, as illustrated in Figure 3.1. Initially, when an inventor develops a new invention, the patent application is submitted to the patent office either directly or through an applicant, such as the inventor's organization or an intellectual property law firm. After a period of review and amendments, the patent office will publish the application. Depending on the needs of the inventor and/or the

applicant, protection for the invention can be sought from one or multiple patent offices. The reference year for patent analysis is determined by the earliest filing year of patents within a family. This method ensures the date used closely approximates the actual time of invention.

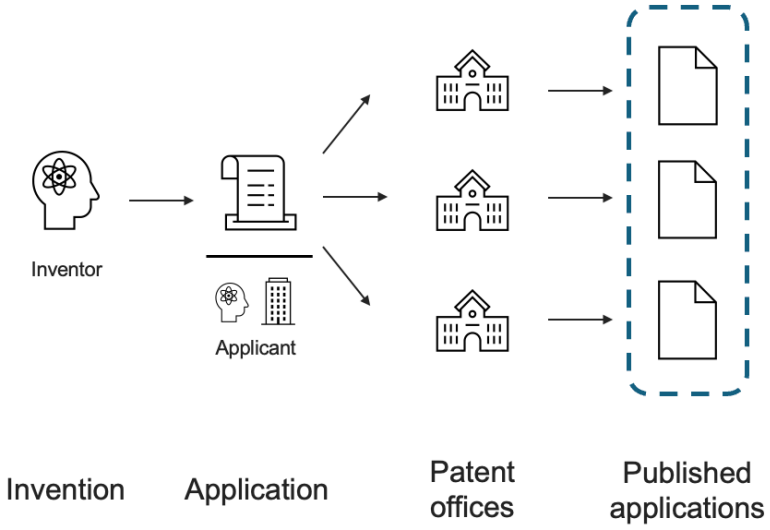

Figure 3.1: Patent invention process

Source: Authors' design based on PATSTAT Global Data Catalog

The PATSTAT database includes person country codes for both inventors and applicants, which do not necessarily correspond to nationality but are generally considered to represent the country of residence of the inventor or applicant. Typically, the inventor is regarded as the moral owner of the invention, while the applicant is considered the legal owner. Therefore, the country code of the inventor is often interpreted as the country where the inventive activity took place, whereas the country code of the applicant is seen as the country of patent ownership. In this project, the country code of inventors or applicants is denoted as "Origin," and the location where the patent is filed is referred to as "Destination." For example, a patent family with 4 inventors – 3 residing in the US and 1 in country Singapore – will count as one observation for each of these two countries. Additionally, when seeking intellectual property protection for a new invention, references to existing patents are necessary. This process involves forward citations for existing patents and backward citations for the new invention.

In the PATSTAT database, patents are grouped into 5 sectors and 35 technical fields (see Figure 3.2). Patents can be associated with multiple technological sub-fields. To account for this, when counting patents in each field, technology field weights are assigned proportionally based on

the number of sub-fields within each broader category. For example, a patent associated with three sub-fields in electrical engineering and two sub-fields in chemistry would have a technology field weight of 0.6 in electrical engineering and 0.4 in chemistry.

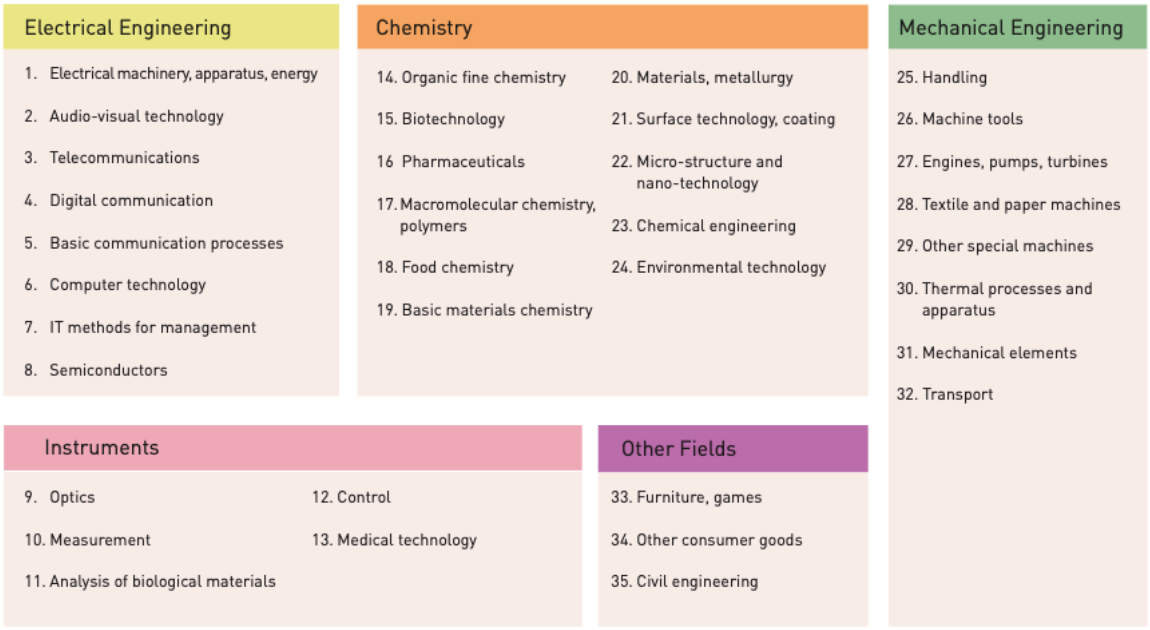

Figure 3.2: Patent classification

Source: Authors' design based on PATSTAT Database

3.3. Identification of patents in emerging sectors

In addition to exploring overall patent collaboration between Singapore and the United States, we focus on five technology domains: clean technology, artificial intelligence, semiconductors, quantum technology, and biotechnology. Clean technology patents are identified using an International Patent Classification (IPC) code–based taxonomy aligned with the environmental innovation framework of Haščič and Migotto (2015) and further refined through the 'green codes' methodology outlined by Favot et al. (2023). Semiconductors patent selection follows the classification scheme proposed by Hoeren, Guadagno, and Wunsch-Vincent (2015), ensuring comprehensive coverage of semiconductor process, device, and material patents. For quantum technology, we adopt IPC code filters derived from the United Kingdom (UK) Intellectual Property Office's quantum technology overviews (IPO, 2013; IPO, 2014). Biotechnology patents are classified according to the revised statistical definitions for biotechnology proposed by Friedrichs and van Beuzekom (2018), capturing both traditional and emerging biotech innovations. And finally, a keyword-based query approach is employed

to identify artificial intelligence patents, drawing on the patenting patterns and keyword sets identified by Leusin et al. (2020), with relevant AI terms searched within patent titles and abstracts.

4. Singapore's innovation landscape

This section presents patent application trends in Singapore, drawing on data by technology sector, applicant type, and advanced or emerging technology areas. The analysis highlights long-term trends, sectoral distributions, and the shifting balance between corporate applicants and individual inventors. Taken together, the findings show how Singapore's intellectual property ecosystem has evolved into a hub for high-tech innovation, aligned with global technological and economic priorities.

4.1. Patent application trends by country of origin

Patent applications per million population rose sharply from 1997 to 2005, reflecting Singapore's deliberate repositioning as an innovation-driven economy (Figure 4.1). The surge coincided with early implementation of USSFTA reforms, which provided greater certainty for foreign investors and stimulated IP-related activity.

Patent applications by both applicants and inventors generally follow similar upward trends (see Figure 4.1). However, after 2003, filings by inventors consistently lag behind those by applicants. This divergence points to the significant presence of foreign entities, often multinational corporations or international partnerships. These entities might be applying for patents for inventions developed elsewhere (possibly even by inventors in other countries) and using Singapore as a base for intellectual property management and commercialization. This pattern may also highlight the structure of Singapore's innovative ecosystem, where larger corporations or international partnerships play a predominant role in patent filings. This can be contrasted with smaller-scale or independent inventor activities which might not translate into actual patent applications at the same rate.

Around 2010, filings at the IPOS surged. This shift is indicative of Singapore's deliberate policy efforts to attract more IP activity and its emergence as a preferred jurisdiction for regional and international patent filings.

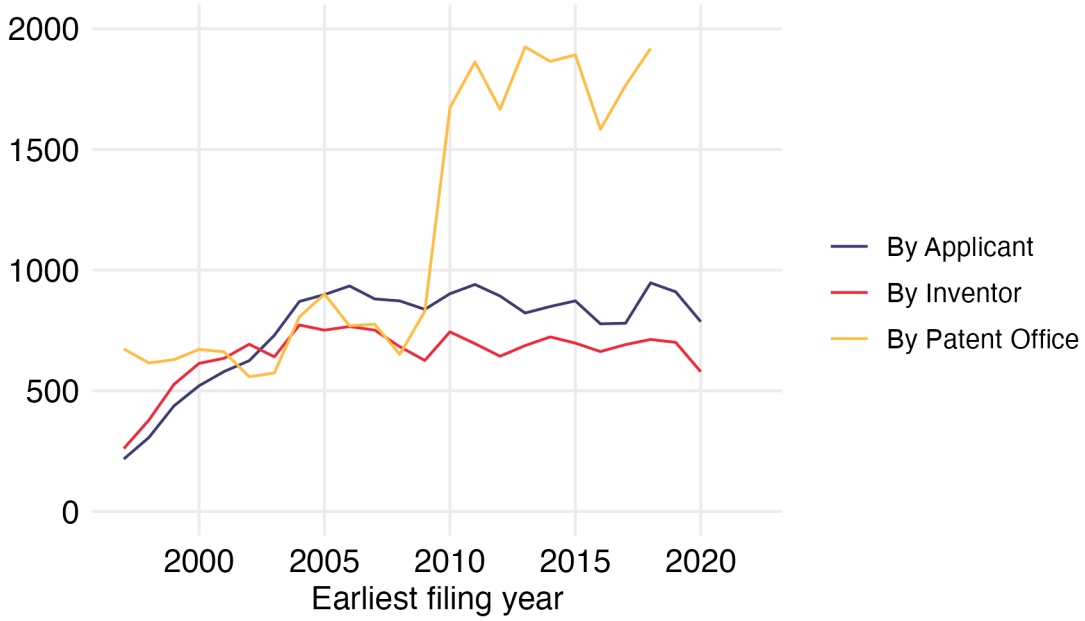

Figure 4.1. Number of patent applications per million population, 1997-2020
Source: Authors' calculations based on PATSTAT Database

Patent families – collections of filings for the same invention across multiple jurisdictions – provide further insight (see Figure 4.2). Both applicant-filed and inventor-filed patent families show steady growth from the late 1990s until around 2005, followed by periods of stagnation and then a resurgence after 2015, possibly reflecting advances in emerging fields (AI, biotech, green tech). This patten suggests a surge in international patent filings originating from Singapore and deeper integration into global innovation networks. Additionally, applicants clearly pull ahead of inventors in patent family counts, showing that organizations (companies, universities, etc.) are expanding their international patenting strategies, while individual inventors have slower growth.

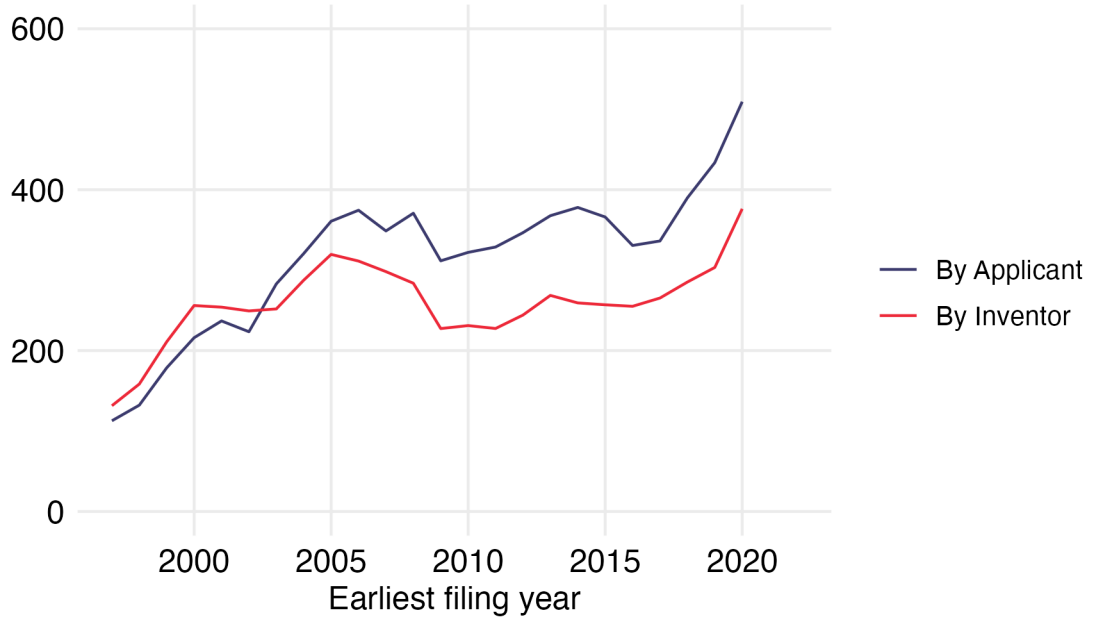

Figure 4.2. Number of patent families per million population, 1997-2020

Source: Authors' calculations based on PATSTAT Database

Table 4.1 depicts the top ten patent applicants in the Singapore patent office, revealing a landscape heavily dominated by corporations, with eight out of the ten entities being companies. This reflects Singapore's strong focus on commercial research and development, particularly in the technology and electronics sectors. However, it is notable that the government and academia also feature prominently, with ASTAR (the Agency for Science, Technology and Research) and the National University of Singapore (NUS) both ranking within the top ten. This shows that while private enterprise drives most of the patenting activity, public research institutions and universities remain important contributors to Singapore's innovation ecosystem.

At the top of the list, Lenovo (Singapore) stands out with 2,885 filings, far surpassing all other applicants. This signals both heavy R&D investment and a strategic use of Singapore as a hub for intellectual property protection. Following Lenovo are AAC Technologies with 1,888 filings and Avago Technologies with 1,838, both strong players in consumer electronics and semiconductor technologies. ASTAR comes next with 1,610 filings, the only government-linked entity in the ranking, reflecting the state's ongoing role in fostering scientific advancement and technology transfer.

The middle tier includes STATS Chippac (1,234 filings), NUS (1,193), and Mediatek Singapore (1,069). Here, semiconductors continue to dominate, but the presence of NUS

highlights the role of academia in contributing to patenting activity, particularly in applied research. The bottom three – Chartered Semiconductor (903), Lenovo Enterprise Solutions (900), and Globalfoundries Singapore (898) – still represent significant numbers, reinforcing the point that the electronics and semiconductor industries remain at the heart of Singapore's intellectual property landscape.

Name	**Type**	**Size**
Lenovo (Singapore)	Company	2,885
AAC Technologies	Company	1,888
Avago Technologies General IP (Singapore)	Company	1,838
ASTAR	Gov Non-Profit	1,610
STATS Chippac	Company	1,234
NUS	University	1,193
Mediatek Singapore	Company	1,069
Chartered Semiconductor Manufacturing	Company	903
Lenovo Enterprise Solutions (Singapore)	Company	900
Globalfoundries Singapore	Company	898

Table 4.1. Top 10 applicants in Singapore patent office, 1997-2020
Source: Authors' calculations based on PATSTAT Database. Note: Size denotes the number of patent families.

Overall, this ranking underscores three key patterns. First, corporate entities dominate Singapore's patent system, accounting for the vast majority of filings. Second, there is clear sectoral concentration in ICT and semiconductors, reflecting Singapore's industrial priorities and comparative advantages. Third, public institutions such as ASTAR and NUS provide a strong complementary role, ensuring that government research and academia also contribute significantly to innovation. Lenovo's exceptionally high filing activity compared to others suggests a particularly aggressive intellectual property strategy, further highlighting how global firms leverage Singapore's IP-friendly environment.

There have also been significant shifts in inventor origins of applications filed at IPOS over 1997 to 2020 (Figure 4.3). Initially, from 1997 to around 2004, patent applications remained relatively stable and low, largely dominated by inventors from the US and Japan. However,

after 2004 – when USSFTA provisions came into force – applications increased sharply, peaking in 2013. US inventors consistently accounted for a large share, underscoring the durability of US – Singapore innovation ties.

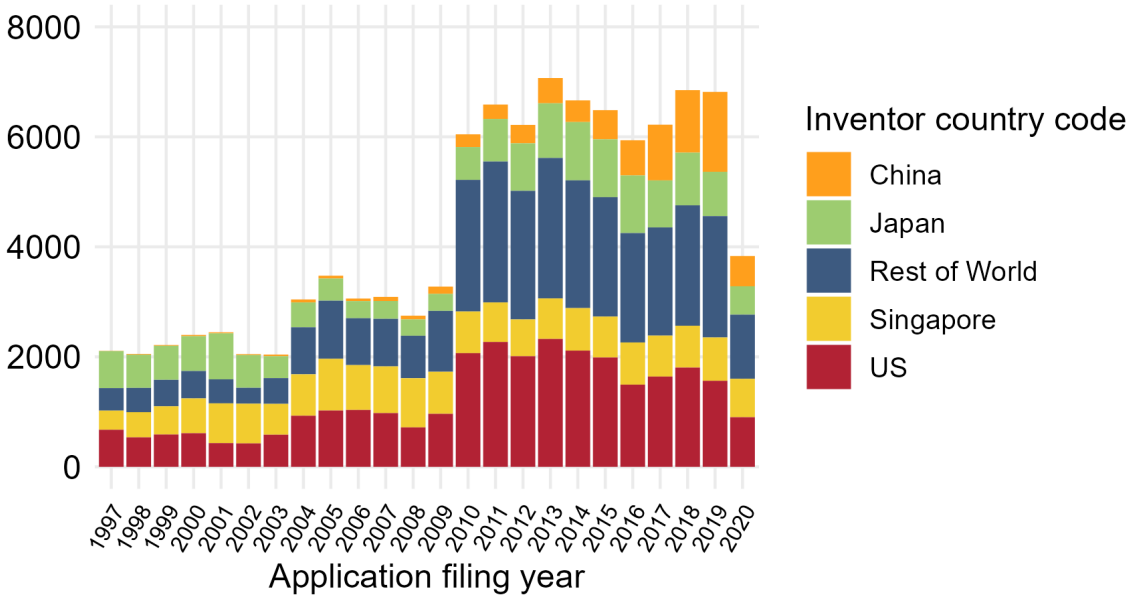

Figure 4.3. Patent applications filed in IPOS by inventor country
Source: Authors' calculations based on PATSTAT Database

Singapore-based inventors also significantly increased their contribution, especially post-2000, underscoring growth in domestic innovation capacity. Inventors from the "Rest of World" category also raised their presence, underscoring Singapore's increased integration into the global innovation network. Japan inventors continued to play a steady but gradually diminishing role over recent years, while patent filings from China inventors saw marked growth from 2010 onward, indicative of China's expanding global technological influence. After 2013, total patent filings experienced a gradual decline, likely influenced by broader global economic factors, evolving patenting behaviours, or changing technological priorities. Overall, this trend illustrates Singapore's evolution into a diverse international innovation ecosystem.

4.2. Patent activity by technology sector

Patent applications by sector reflect both Singapore's long-term innovation strategy and the institutional reforms introduced by the USSFTA. From 1995 to 2005, patenting activity

expanded rapidly across nearly all fields, coinciding with the early implementation of TRIPS-plus provisions that reassured multinational firms of strong IP protection. Growth slowed between 2005 and 2015, mirroring both global economic cycles and the consolidation of patenting strategies, but accelerated again after 2015, led by steep increases in electrical engineering and chemistry (Figure 4.4). This renewed surge reflects Singapore's deliberate efforts to position itself at the forefront of digitalization, biotechnology, and sustainability.

Electrical engineering shows the strongest long-term growth, followed by instruments, highlighting Singapore's industrial focus on high-tech and electronics. Chemistry, mechanical engineering, and miscellaneous categories remain smaller but have steadily expanded, with chemistry becoming increasingly important in recent years. The momentum in chemistry, particularly pharmaceuticals and life sciences, aligns with the USSFTA's provisions on patent term extensions, data exclusivity, and pharmaceutical IP protection, which probably directly incentivized multinational corporations to locate biomedical R&D in Singapore.

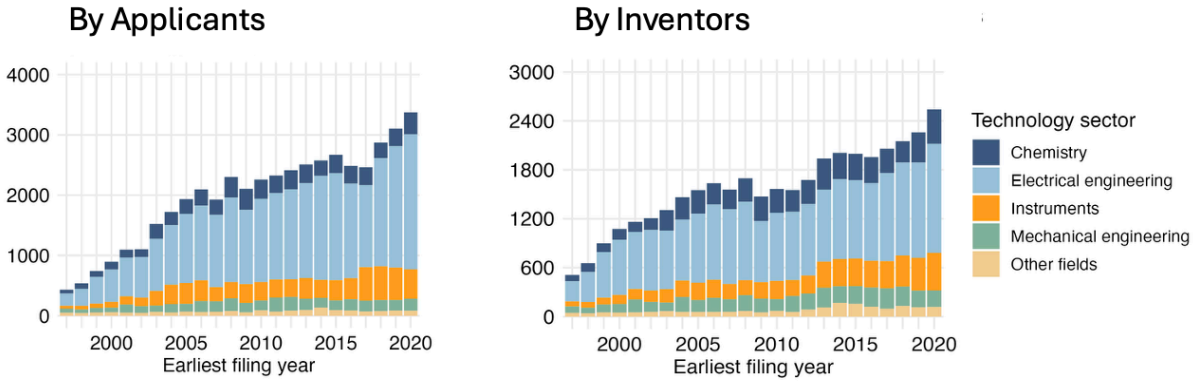

Figure 4.4. Patent applications by technology sector

Note: The figures show the numbers of patent families. Source: Authors' calculations based on PATSTAT Database

A comparison between applicants and inventors reveals complementary strengths. Applicants have consistently filed more patents overall – around 3,800 families compared to 2,600 for inventors – with electrical engineering dominating corporate filings. Inventors, by contrast, demonstrate stronger activity in chemistry, particularly in pharmaceuticals and life sciences. This pattern underscores how corporations drive large-scale technological advances in electronics and digital technologies, while universities and research labs contribute disproportionately to biomedical and chemical sciences. It reflects the dual impact of USSFTA-

driven corporate confidence and state-led investment in public research institutions such as A*STAR and NUS.

Patent applications filed directly with the IPOS provide further insights into the country's growing role as a regional hub. From the late 1990s to the mid-2000s, applications remained relatively stable before declining between 2005 and 2010. This dip may reflect shifts in global patenting strategies, with applicants focusing on larger patent offices during that period, or possible fluctuations in data reporting.

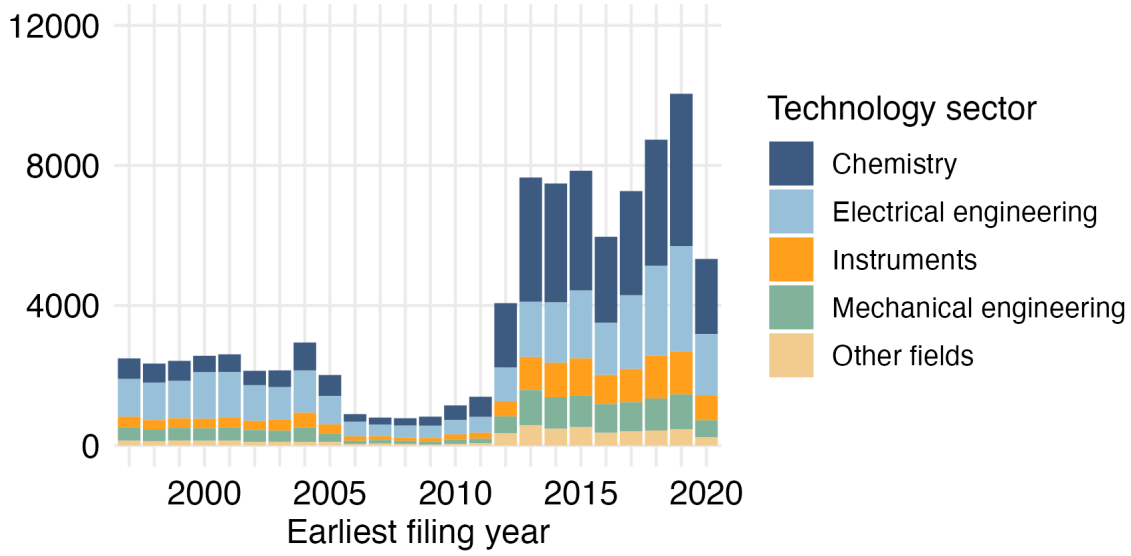

Figure 4.5. Patent applications by technology sector received by IPOS
Source: Authors' calculations based on PATSTAT Database

After 2010, filings at IPOS rose dramatically, peaking at nearly 10,000 applications per year by 2020. The increase was driven by strong growth in chemistry and electrical engineering, consistent with global trends in pharmaceuticals, biotechnology, and electronics. These trends highlight how USSFTA provisions, coupled with domestic policy, reinforced Singapore's attractiveness as a trusted jurisdiction for IP protection and commercialization.

4.3. Advanced technology focus: emerging sectors

Examining advanced technologies reveals how Singapore's innovation system has evolved beyond its early hardware-centered base into a more diversified ecosystem. In the early 2000s,

corporate applicants concentrated heavily on semiconductors, peaking around 2010 before tapering off (Figure 4.6). This pattern reflects both the cyclical nature of the semiconductor industry and Singapore's comparative advantage in ICT. It also mirrors the USSFTA's role in securing Singapore as a trusted base for electronics and high-tech corporate IP filings.

By the mid-2010s, Singapore's innovation portfolio became more diversified, with strong growth in biotechnology and clean technologies. Biotech, in particular, benefitted from USSFTA's pharmaceutical IP provisions, which addressed US concerns about patent protection abroad and incentivized pharmaceutical multinationals to expand local R&D. Clean tech growth reflects Singapore's strategic focus on sustainability, supported by targeted investments and policies.

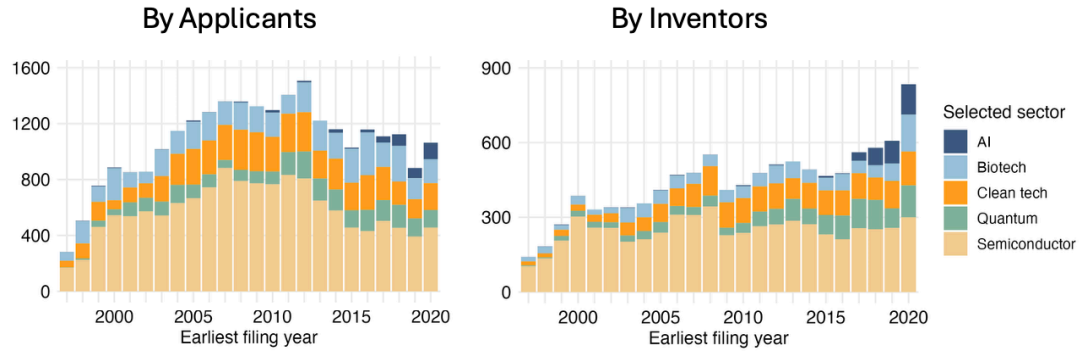

Figure 4.6. Patent applications by advanced technology
Source: Authors' calculations based on PATSTAT Database

AI patents surged after 2015, reflecting the next wave of digital transformation. While corporate applicants remain central drivers in hardware-centric innovation, particularly semiconductors, inventors contribute more strongly to biotech, clean tech, and niche fields like quantum and more recently, AI, underscoring the role of public research institutions in emerging fields. Quantum technologies, though small in scale, remain steady, suggesting niche innovation activity.

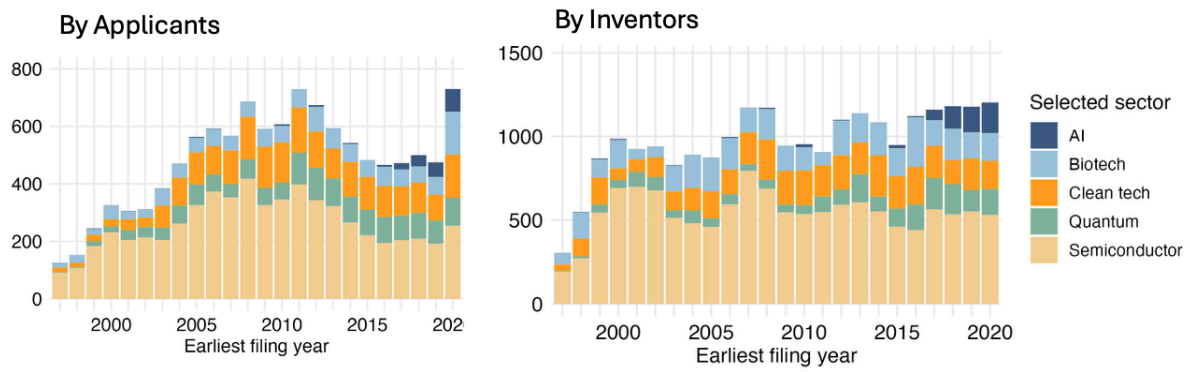

Figure 4.7. Patent family applications by emerging technology and applicant origin
Source: Authors' calculations based on PATSTAT Database

IPOS data reinforces these trends. In the late 1990s and early 2000s, filings were modest and heavily concentrated in semiconductors. After 2010, however, applications surged, reaching nearly 3,500 per year by 2019 (Figure 4.8). Biotech and clean tech now account for the largest shares, reflecting Singapore's shift toward health sciences, sustainability, and green innovation. While semiconductors remain important, their relative weight has declined. AI filings emerge prominently only in the late 2010s, consistent with global technological priorities.

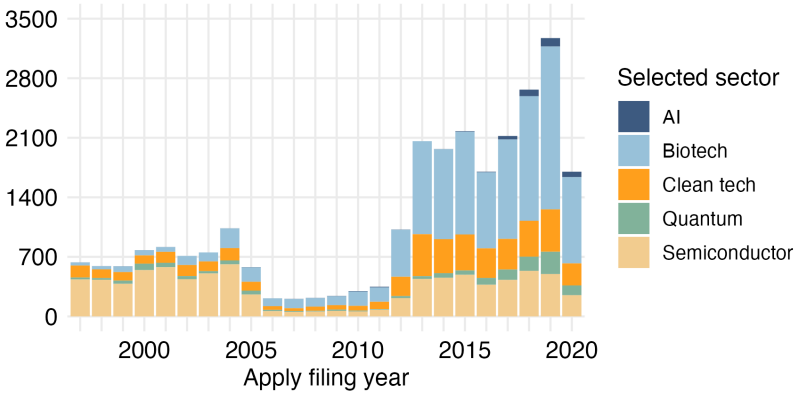

Figure 4.8. Patent applications by advanced technology received by IPOS
Source: Authors' calculations based on PATSTAT Database

Corporate applicants continue to dominate high-volume sectors such as semiconductors and ICT, while inventors and public institutions play a critical role in life sciences and sustainability-focused fields. Together, these dynamics show how Singapore leveraged the USSFTA not only to strengthen IP protection but also to embed itself in global innovation networks. The resulting balance – between foreign corporations and domestic institutions,

between hardware and new digital/biotech fields – illustrates Singapore's transformation into a credible and diversified innovation hub.

5. US – Singapore engagement in innovation activities

5.1. Overview of innovation collaboration

The trajectory of co-invented patent families between Singapore and the United States highlights the tangible impact of strengthened IP regimes and cross-border collaboration. In the mid-1990s, joint patenting activity was modest, with fewer than 100 co-invented patents annually. By the late 2010s, however, the number had risen to over 400 per year (Figure 5.1, left panel). This expansion was particularly pronounced after the USSFTA came into effect, suggesting that the agreement's TRIPS-plus provisions – especially in patent protection and enforcement – reduced legal uncertainty and reassured US partners of Singapore's reliability as an innovation hub. A brief slowdown around 2008–2010, linked to the global financial crisis, gave way to renewed growth, with a sharp post-2015 acceleration. These trends underscore the strengthening of inventor-level ties, often forged through partnerships between universities, research institutes, and individual scientists. Such collaborations enabled Singapore-based inventors to leverage US expertise, infrastructure, and global networks.

Co-applied patent filings follow a somewhat different trajectory. Growth began around 1997, accelerating after 2004, and peaking at over 400 patent families during 2007–2010 (Figure 5.1, right panel). This surge reflected Singapore's role in global electronics and semiconductor supply chains at the time, when corporate collaboration was particularly strong. After 2010, however, co-applications fell sharply to fewer than 100 by the mid-2010s, likely due to strategic shifts in corporate IP management as firms consolidated filings in larger jurisdictions or restructured R&D portfolios. More recently, a modest recovery has emerged, hinting at new areas of corporate collaboration in artificial intelligence, clean technology, and next-generation life sciences.

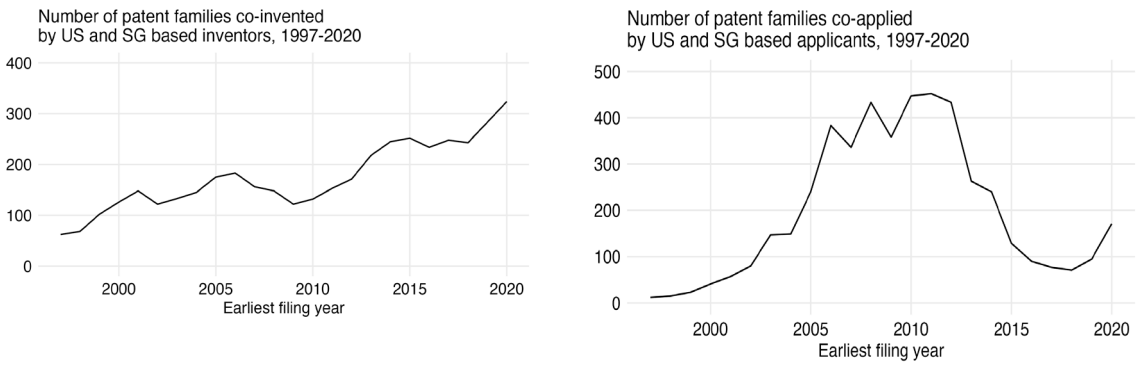

Figure 5.1. Trends in patent families co-invented and co-applied by US and Singapore
Source: Authors' calculations based on PATSTAT Database

Overall, the contrast between corporate and inventor collaboration is striking. While corporate co-applications peaked in the 2000s and then declined, inventor-level co-inventorship has grown steadily, pointing to deeper research ties at the scientific level. Singapore thus benefits in two complementary ways: (1) inventor partnerships with US counterparts strengthen local talent, research capacity, and access to cutting-edge knowledge, while (2) corporate partnerships, though cyclical, historically anchored Singapore in global value chains and are now re-emerging in high-tech frontier sectors.

The exclusivity of bilateral ties is also notable. For most of the period, the majority of co-invented patent families involve only US and Singapore-based inventors (coded as "2" in Figure 5.2). Yet since the mid-2000s, there has been a visible rise in patent families involving three or more countries, reflecting the increasing internationalization of innovation. US – Singapore collaborations now often serve as hubs that attract additional global partners, reinforcing the idea that bilateral ties remain the cornerstone but are embedded within wider multinational networks.

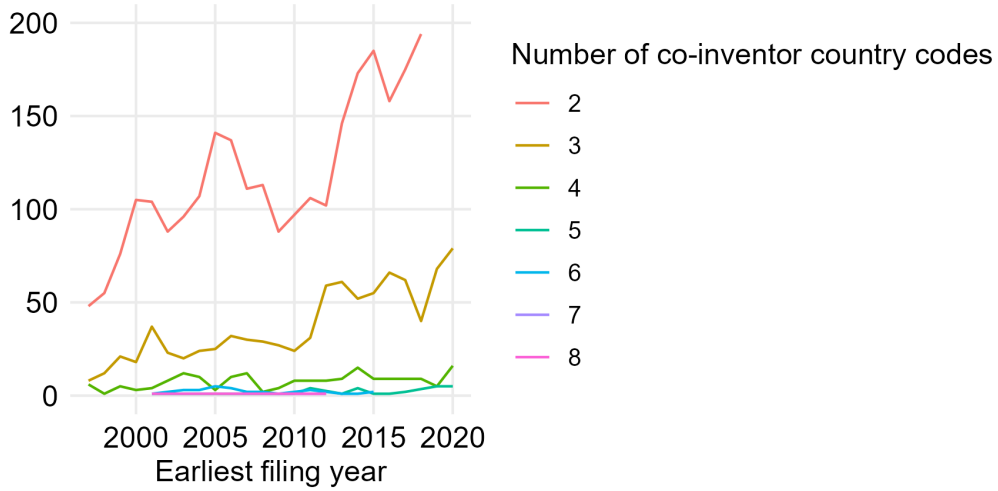

Figure 5.2. Number of countries involved in US – Singapore co-invented patent families
Source: Authors' calculations based on PATSTAT Database

Singapore-based inventors have also expanded their global reach. Figure 5.3 shows the rise in co-invented patent families over time, with the United States emerging as Singapore's most important partner, particularly after 2003. This reflects the growing weight of US – Singapore collaboration in Singapore's innovation system. In recent years, China has also become a major partner, reflecting shifting global innovation dynamics. Other key partners include Japan, Germany, Taiwan, and India, demonstrating Singapore's increasingly diversified global research network. In this sense, Singapore has consolidated ties with traditional partners while also embedding itself in the fast-growing Asian innovation ecosystem.

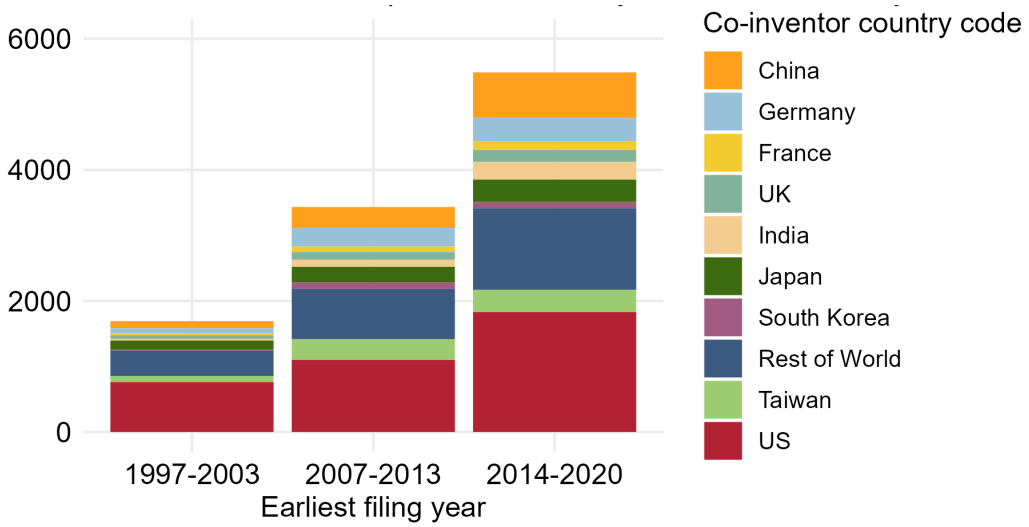

Figure 5.3. Number of patent families co-invented by Singapore and selected countries
Source: Authors' calculations based on PATSTAT Database

Overall, the rise in co-invented patents reflects Singapore's evolution from a relatively modest research partner in the 1990s to a fully integrated player in global innovation. Singapore has steadily deepened its collaboration with the US, ensuring access to world-leading research expertise and global innovation networks. At the same time, Singapore has diversified its international partnerships, particularly with China and other Asian economies, aligning itself with shifting global innovation centers. This dual approach strengthens Singapore's resilience and competitiveness, embedding it within both established and emerging technology hubs.

While the innovation partnership between the US and Singapore remains predominantly bilateral, the participation of additional ASEAN countries in collaborative patent activities continues to be limited (Figure 5.4). Among ASEAN nations, Malaysia stands out as the most active co-inventor, followed by sporadic contributions from countries such as Indonesia, the Philippines, Thailand, Vietnam, and Brunei. The steady contributions from Malaysia and the growing inclusion of other ASEAN partners point to Singapore's role as a regional innovation hub, serving as a bridge between Southeast Asia and the global research community. These trends highlight Singapore's dual strategy: anchoring itself in global innovation networks while also nurturing partnerships within Southeast Asia, reinforcing its position as both a global connector and a regional leader in innovation.

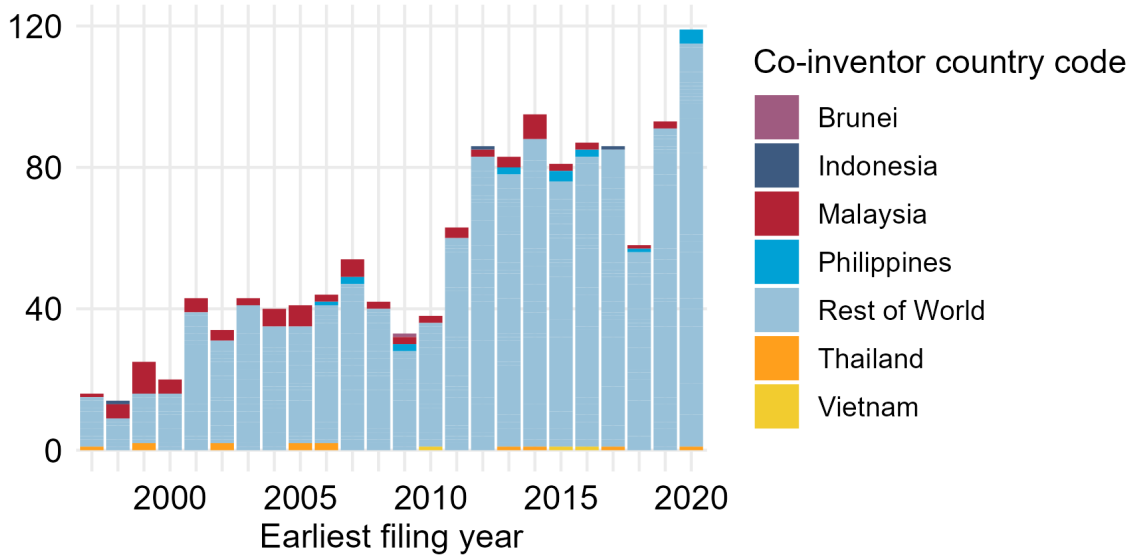

Figure 5.4. Number of patent families co-invented with Singapore, US, and other countries
Source: Authors' calculations based on PATSTAT Database

A sectoral breakdown of patent holders in US – Singapore co-invented patent families reveals a persistent dominance by companies and individuals, which account for the largest share of collaborative innovation activities throughout the period (Figure 5.5). Their dominance underscores how collaboration with US corporations has provided Singapore-based companies with access to global value chains, advanced technologies, and commercialization pathways. Universities also play notable roles, maintaining a consistent but smaller share over time. These academic partnerships with US institutions have been important for knowledge transfer, talent development, and advancing research. Contributions from government and non-profit organizations, as well as hospitals, are present but relatively limited. These trends suggest that while cross-border corporate partnerships are the primary drivers of US – Singapore patent co-invention, academic and individual collaborations remain important contributors to the overall innovation ecosystem. The stable distribution over time highlights the enduring importance of the private sector, complemented by ongoing input from academia and other sectors.

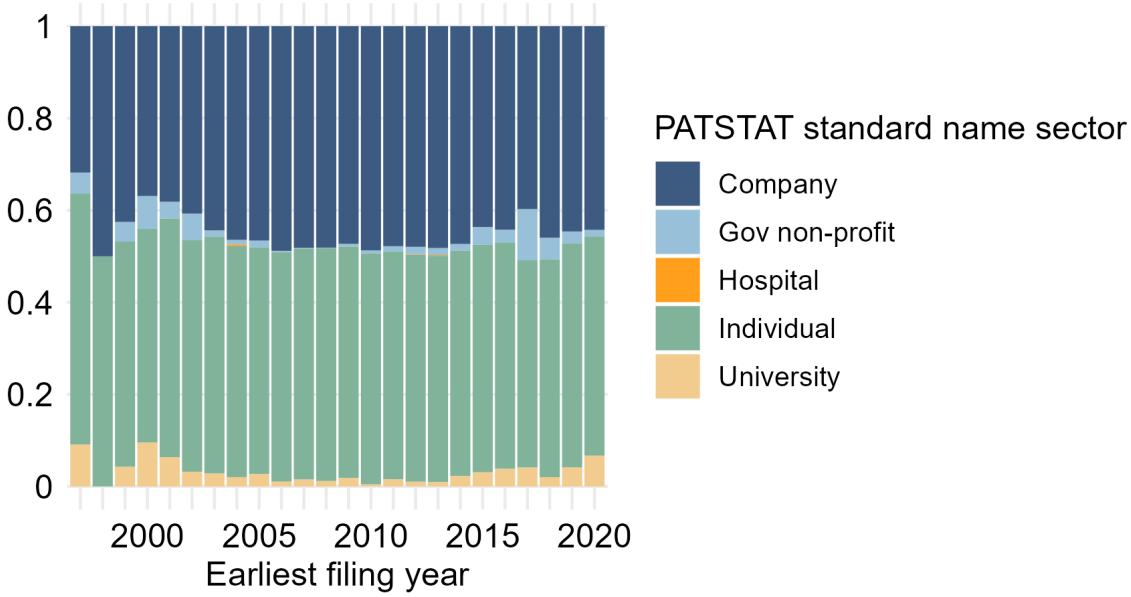

Figure 5.5. Share of patent holders co-invented by US and Singapore

Source: Authors' calculations based on PATSTAT Database

5.2. Internationalisation of co-inventions

To better capture the evolving international dimensions of US – Singapore collaboration, we apply indicators proposed by Guellec and de la Potterie (2001), focusing on the scope and direction of cross-border co-invention.

One measure is the share of US – Singapore patent families relative to all patents involving at least one Singapore-based inventor engaged in international collaboration. Figure 5.6 presents these shares at the global level, at the USPTO, and at IPOS.

In the late 1990s, US – Singapore co-inventions represented a disproportionately large share of Singapore's international collaborations – above 0.6 at the USPTO and close to 0.5 globally. This reflected the US's central role as Singapore's primary partner during the formative years of its innovation system, when cross-border networks were still limited and Singapore was deeply embedded in US-led value chains.

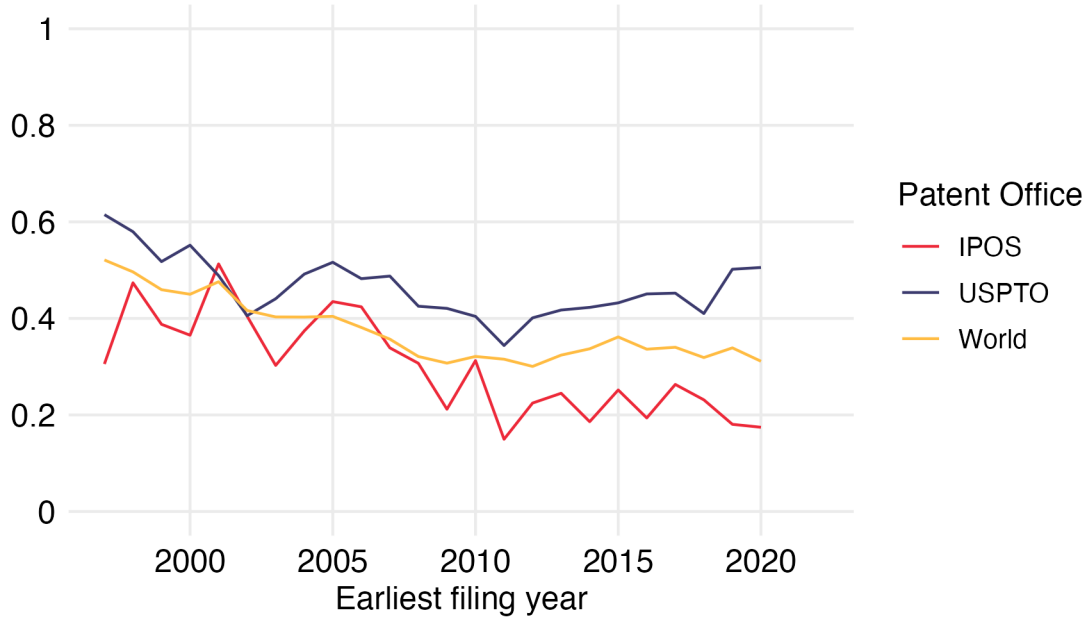

Figure 5.6. Share of patents co-invented by US and Singapore residents among total patents
Source: Authors' calculations based on PATSTAT Database

Over the next two decades, divergent patterns emerged across patent offices. At the USPTO, the share of US – Singapore co-inventions remained strong – fluctuating but consistently between 0.4 and 0.5. This underscores the enduring importance of the US as a key destination for globally significant technologies involving Singapore-based inventors. By contrast, at IPOS the share declined from around 0.4 in the late 1990s to below 0.2 by 2020, suggesting that while collaboration with US partners remains robust, firms and inventors do not prioritize filing these patents domestically. Instead, they direct them toward larger global markets with greater commercial relevance.

On the global level, the share of US – Singapore collaborations also declined gradually, from about 0.5 in the late 1990s to around 0.3 by 2020. This reflects the diversification of Singapore's international innovation partnerships over time. While the US remains a dominant partner, new collaborations with countries such as China, Japan, and other Asian economies have gained ground, reducing the US share of the overall pool.

The distribution of patent ownership reveals a further dimension. Figure 5.7 shows the share of Singapore-origin inventions owned by US firms as a share of Singapore's total domestic inventions. In the late 1990s, US companies held the lion's share – close to 90% of Singapore-origin inventions at the USPTO and globally, and around 60–70% at IPOS. This dominance reflected Singapore's early reliance on US multinationals in semiconductors, electronics, and pharmaceuticals, consistent with the city-state's role as a hub for US-led global value chains.

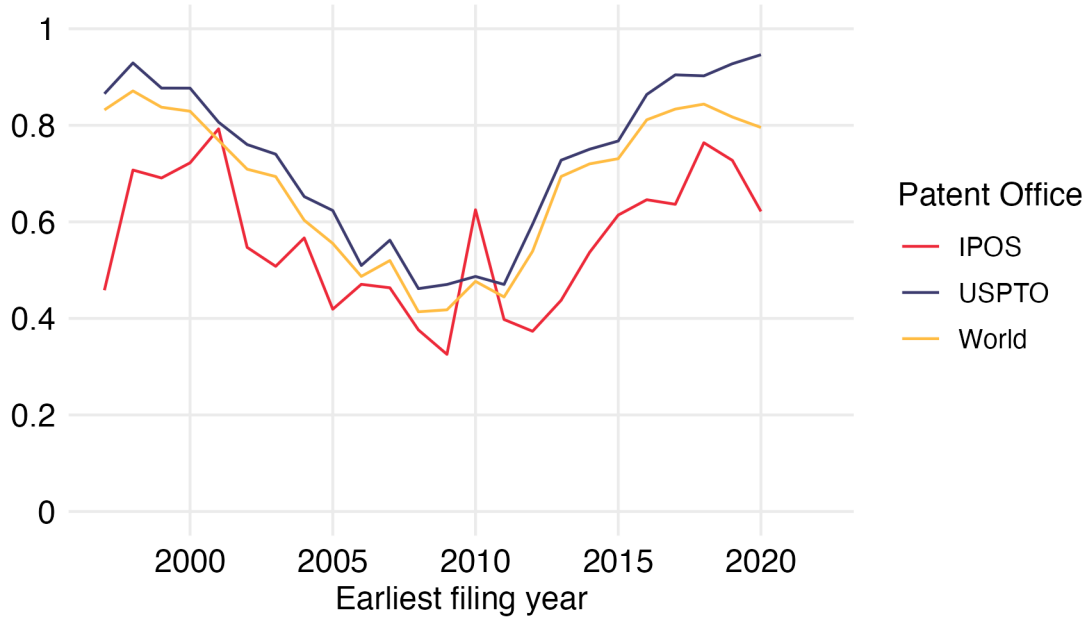

Figure 5.7. Share of domestic inventions owned by foreign firms
Source: Authors' calculations based on PATSTAT Database

By the 2000s, however, US ownership shares declined steadily across all offices, reaching their lowest point around 2010. At the USPTO, the share dipped below 50%, while at IPOS the decline was even sharper. This shift reflected the rise of domestic firms, non-US multinationals, and public research institutions, signaling a more diversified innovation base.

After 2010, the trend reversed. US ownership shares rose again, exceeding 90% at the USPTO and 80% globally by 2020. Even at IPOS, where US ownership had been lower, a rebound was visible. This re-consolidation of US influence likely reflects US dominance in frontier fields – artificial intelligence, advanced semiconductors, and biotechnology – where Singapore-based research is increasingly embedded. The double-edged nature of this trend is clear: while US ownership ensures that Singapore's inventions are integrated into global commercialization pathways, it also raises concerns about local value capture.

A complementary perspective comes from Figure 5.8, which measures the share of US-based inventions owned by Singapore-based firms. At the USPTO, co-invention shares consistently range from 0.6 to 0.8, with global benchmarks close behind at 0.55–0.75. By contrast, IPOS filings show much lower co-invention levels – between 0.25 and 0.45 – suggesting a dual-track system. Inventions intended for global markets are disproportionately tied to US partners, while those filed locally reflect more diversified collaboration.

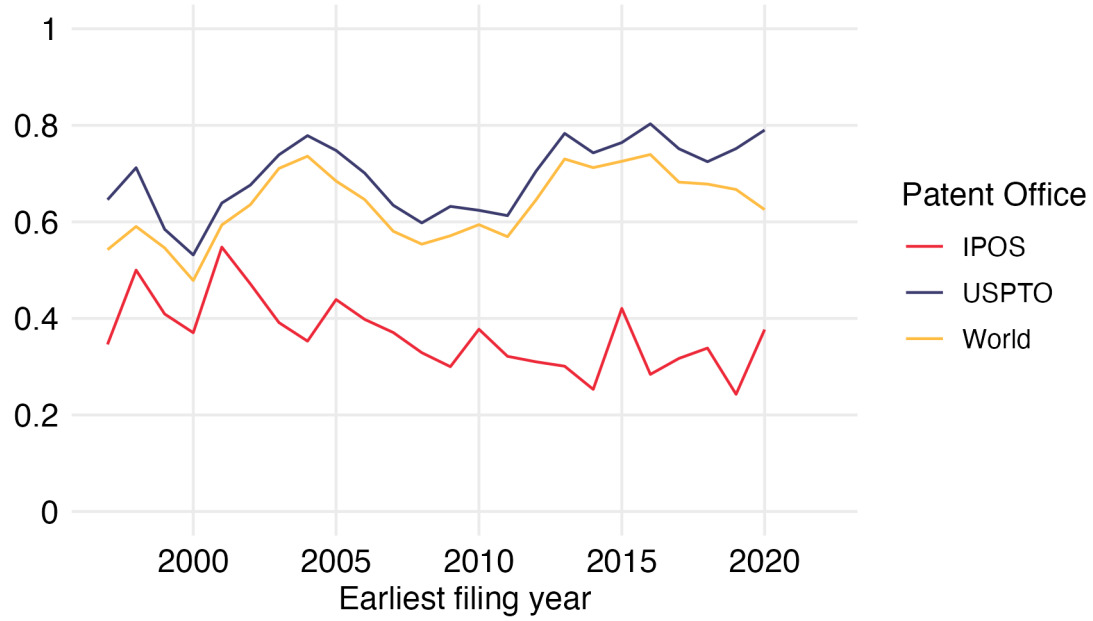

Figure 5.8. Share of foreign inventions owned by domestic firms
Source: Authors' calculations based on PATSTAT Database

Taken together, these trends confirm the dual nature of US – Singapore collaboration: foundational and enduring, yet increasingly embedded in a diversified and globalized innovation portfolio.

5.3. Sectoral and technology breakdown

Sectoral patterns also reveal the alignment of collaborative patenting with national industrial strategies (Figure 5.9). Electrical engineering consistently dominates joint patent families, reflecting Singapore's longstanding investments in semiconductors, electronics, and ICT. Chemistry, though more cyclical, gained renewed importance by 2020, likely tied to collaborations in pharmaceuticals, materials science, and petrochemicals – sectors directly supported by Singapore's biomedical and chemicals strategies. Instruments-related patents saw strong growth from the mid-2010s, reflecting synergies in precision engineering and medical technologies, while mechanical engineering and other fields, though smaller in scale, expanded modestly in parallel. Together, these patterns illustrate how US – Singapore innovation partnerships have diversified in ways that mirror both countries' comparative strengths and strategic priorities.

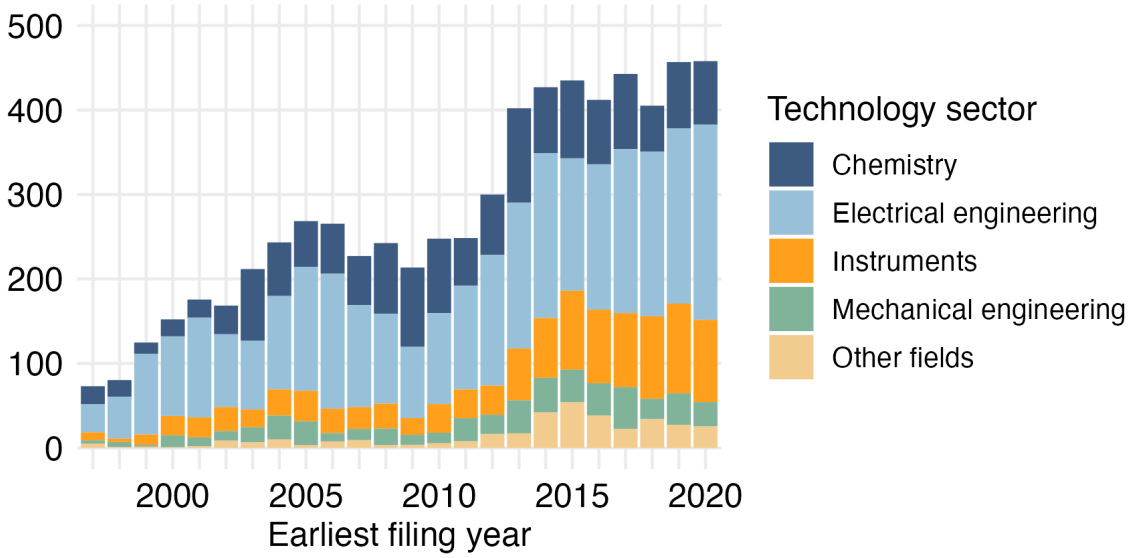

Figure 5.9. Number of patent families co-invented by US and Singapore inventors by technology sector

Source: Authors' calculations based on PATSTAT Database

A closer look at advanced technologies reveals an important qualitative shift (Figure 5.10). Historically, semiconductors accounted for the bulk of joint patents, reflecting Singapore's deep manufacturing base and the US's global design strengths. However, since 2010, new domains have surged. Biotech emerged as a consistent secondary driver, tied to Singapore's biomedical sciences strategy. Clean tech patents grew steadily, signalling policy alignment

with sustainability priorities. Quantum technologies, while small in scale, showed clear upward momentum. Most strikingly, artificial intelligence patents appeared strongly after 2015, expanding rapidly by 2020. This evolution illustrates how US – Singapore collaboration has moved beyond hardware-centric innovation into digital, life sciences, and frontier technologies.

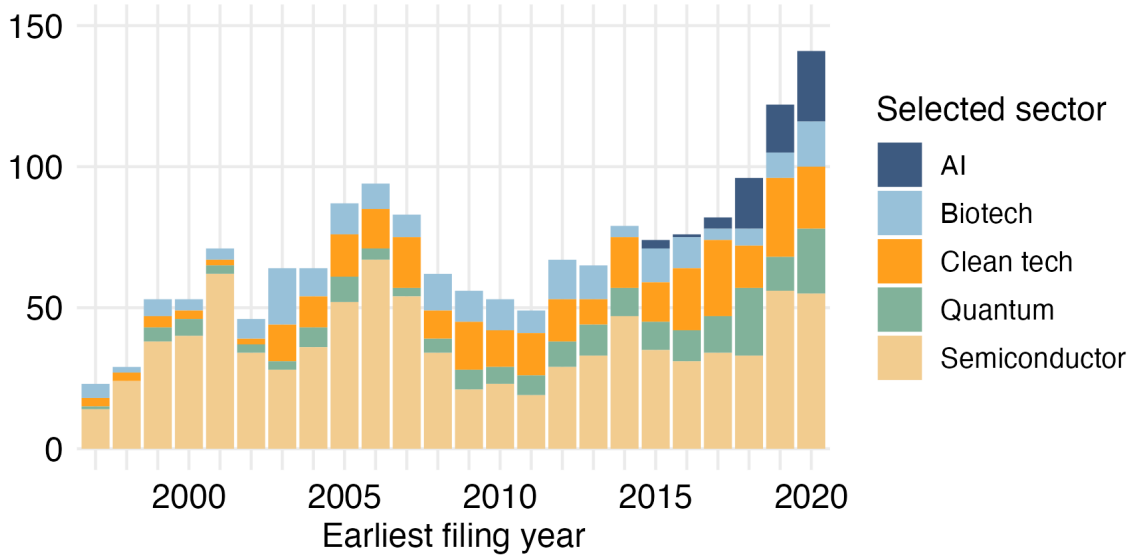

Figure 5.10. Number of patent families co-invented by US and Singapore inventors by advanced technology

Source: Authors' calculations based on PATSTAT Database

The policy implications are twofold. First, the evidence confirms that high-standard IP frameworks and trade agreements like the USSFTA can stimulate cross-border co-invention by lowering legal risks and strengthening trust between partners. Second, while initial gains were anchored in established sectors, long-term dynamism depends on diversification into frontier domains. The plateauing of overall patent numbers after 2015 in Figure 5.9 suggests that sustaining growth will require new policy levers – support for AI, green technologies, and quantum research (Figure 5.10), as well as fresh incentives to attract multinational R&D investment.

In this light, US – Singapore co-invented patents should not be read simply as a measure of legal compliance but as indicators of how trade policy, industrial strategy, and technological priorities interact. The shift from semiconductors to advanced technologies demonstrates

Singapore's ability to adapt its innovation model, embed itself in emerging global value chains, and remain a credible partner in next-generation innovation networks.

The evolution of US – Singapore co-invented patents also reflects a significant broadening of the technology portfolio (Figure 5.11). Between 1997 and 2003, collaboration was highly concentrated: semiconductors accounted for nearly a quarter of all joint patents, with computer technology and audio-visual technology together forming another sizeable share. This concentration mirrored Singapore's role at the time as an advanced electronics manufacturing hub, embedded in global semiconductor and ICT supply chains. Biotechnology, digital communication, and optics were present but relatively modest, while most other fields contributed only marginally.

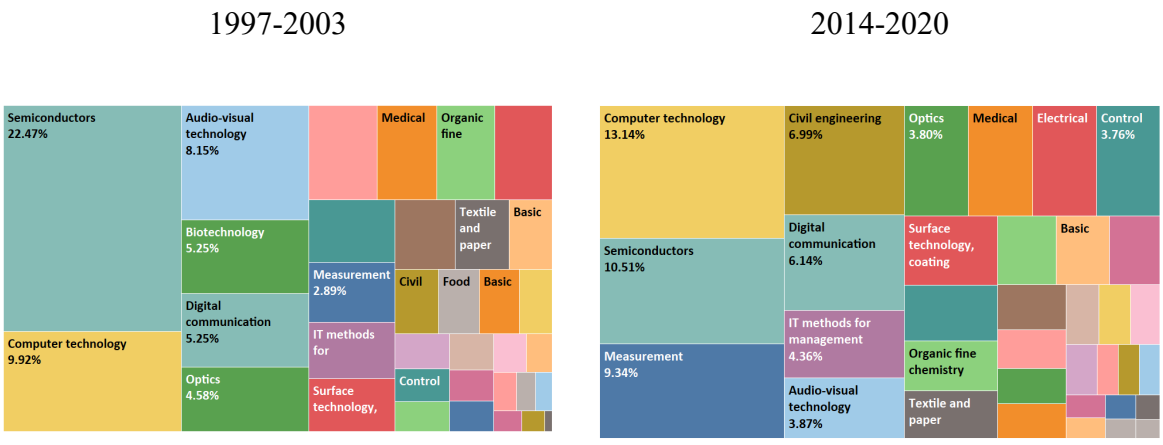

Figure 5.11. Share of technology fields in US – Singapore patent co-invention
Source: Authors' calculations based on PATSTAT Database

By contrast, the 2014–2020 period reveals a much more balanced distribution of co-invented patents. While semiconductors and computer technology remain important, their combined share has declined substantially. A wider range of sectors – including measurement technologies, civil engineering, digital communication, IT methods for management, and surface technologies – gained prominence. Fields such as medical technology, organic chemistry, and electrical engineering also expanded, underscoring Singapore's diversification into life sciences, applied engineering, and materials research. Instead of a narrow concentration, co-invention now spans a broader base, reflecting both Singapore's deliberate policy shift and the dynamic complementarities of the bilateral partnership.

Overall, the shift between these two periods demonstrates how US – Singapore co-invention has evolved from a focus on traditional electronics and computing towards a broader and more balanced portfolio. This trend suggests a maturing bilateral innovation relationship, characterized by greater technological breadth and an ability to adapt to emerging global technology trends.

6. Conclusion

Singapore's innovation trajectory over the past two decades highlights the profound role that international trade agreements can play in shaping national innovation systems. The USSFTA was not merely a trade pact but a catalyst for systemic reform, embedding "TRIPS-plus" IP standards into Singapore's legal and institutional framework. By enhancing certainty and enforcement, these reforms reassured multinational corporations of the security of their intangible assets and elevated Singapore's reputation as a trusted hub for high-value R&D.

The impact is visible in the evolution of the bilateral innovation partnership. Facilitated by the USSFTA and reinforced by national strategies such as the Biomedical Sciences Strategy and successive Research, Innovation and Enterprise (RIE) plans, US – Singapore collaboration has expanded well beyond its early focus on electronics and ICT. Today, co-invention spans artificial intelligence, biotechnology, clean technologies, and even quantum research, reflecting Singapore's deliberate policy choices and adaptability to shifting global technological priorities.

Co-invented patents between the US and Singapore rose steadily after 2004, anchoring Singapore in US-led innovation networks and opening pathways for collaboration between multinational corporations, universities, and research institutes. At the inventor level, collaboration has grown consistently, underscoring the role of academic and laboratory partnerships in strengthening Singapore's research capacity and international connectivity. At the corporate level, activity has been more cyclical, peaking in semiconductors and electronics during the 2000s, then declining as firms consolidated IP strategies globally. Yet recent growth in AI, biotech, and clean technologies signals a renewed corporate dimension aligned with frontier innovation.

The internationalisation of co-invention further illustrates Singapore's transition from dependence on a single dominant partner to a diversified innovation portfolio. While the US

remains central – especially in high-value inventions destined for global markets – new collaborations with China, Japan, and other Asian economies have broadened Singapore's network. This dual orientation, combining an enduring US anchor with emerging Asian partners, has enhanced Singapore's resilience in a multipolar innovation landscape. At the same time, Singapore has consolidated its role as a regional connector, though ASEAN participation in co-invention remains modest beyond Malaysia.

Once narrowly reliant on semiconductors and ICT, Singapore now sustains a more diversified and balanced innovation portfolio, with growing strength in life sciences, green technologies, and digital domains. This reflects deliberate long-term investments in advanced manufacturing, biomedical sciences, and sustainability. The result is not only a larger volume of patents but also a more diverse and strategically aligned portfolio, embedding Singapore within global value chains across healthcare, digital technologies, and emerging green industries.

From a policy perspective, this diversification is critical. A narrow dependence on electronics would have left Singapore vulnerable to technological cycles and geopolitical shocks in global supply chains. By cultivating a balanced innovation ecosystem, Singapore has reduced risk, enhanced resilience, and positioned itself as an attractive hub for high-value R&D. For the US, the partnership secures a reliable Asian partner capable of supporting frontier innovation across multiple domains.

The trajectory of US – Singapore innovation collaboration points to both achievements and challenges. The key achievement lies in the successful use of trade policy to embed strong IP frameworks, attract multinational R&D, and diversify into frontier technologies. The challenge lies in sustaining this momentum: to sustain this diversification while deepening specialization in frontier technologies such as AI, quantum, and clean tech, ensuring that collaboration continues to generate competitive advantage for both partners. Sustaining growth will require continuous policy adaptation, investment in emerging technologies, and strategies that balance global integration with local capability-building.

More broadly, Singapore's experience offers lessons for other small, open economies navigating the global innovation order. First, trade agreements can be used not just for market access but as instruments of institutional reform, signalling reliability to global partners. Second, openness to foreign R&D must be matched with domestic capability-building to ensure that collaboration yields local benefits. Third, diversification – both sectoral and geographic –

is essential for resilience, reducing exposure to technological cycles and geopolitical shocks. Finally, positioning as a regional connector can amplify global integration while strengthening neighbourhood ecosystems. In these respects, Singapore's innovation journey provides a model of how a small state can leverage trade, IP policy, and strategic partnerships to thrive in the knowledge economy.

References:

Chiu, K. (2004). Harmonizing Intellectual Property Law Between the United States and Singapore: The United States-Singapore Free Trade Agreement's Impact on Singapore's Intellectual Property Law. Transnat'l Law., 18, 489.

Dernis, Hélène, and Mosahid Khan. Triadic patent families methodology. No. 2004/2. OECD Publishing, 2004.

Guellec, Dominique, and Bruno van Pottelsberghe de la Potterie. "The internationalisation of technology analysed with patent data." Research Policy 30, no. 8 (2001): 1253-1266.

Ge, Yixuan, Taojun Xie and Chi Zhang (June 2022), "Imputation of Missing Information in PATSTAT Database: A Re-assessment", Research Paper #07-2022, Asia Competitiveness Institute Research Paper Series (June 2022)

Haščič, I. and M. Migotto (2015), "Measuring environmental innovation using patent data", OECD Environment Working Papers, No. 89, OECD Publishing, Paris, https://doi.org/10.1787/5js009kf48xw-en.

Favot, Marinella, Leyla Vesnic, Riccardo Priore, Andrea Bincoletto, and Fabio Morea. "Green patents and green codes: How different methodologies lead to different results." Resources, Conservation & Recycling Advances 18 (2023): 200132.

Hoeren, Thomas, Francesca Guadagno, and Sacha Wunsch-Vincent. Breakthrough technologies–Semiconductor, innovation and intellectual property. Vol. 27. WIPO, 2015.

IPO. "Eight Great Technologies: Quantum Technologies, a patent overview." UK Intellectual Property Office Informatics Team. 2014.

IPO. "Quantum Technologies: A patent review for the Engineering and Physical Sciences Research Council (EPSRC)." UK Intellectual Property Office Informatics Team. October 2013.

Aboy, M., Minssen, T. & Kop, M. Mapping the Patent Landscape of Quantum Technologies: Patenting Trends, Innovation and Policy Implications. IIC 53, 853–882 (2022). https://doi-org.libproxy1.nus.edu.sg/10.1007/s40319-022-01209-3

Friedrichs Steffi and Brigitte van Beuzekom. "Revised Proposal for the Revision of the Statistical Definitions of Biotechnology and Nanotechnology." OECD Science, Technology and Industry Working Papers. 2018.

Leusin, Matheus Eduardo, Jutta Günther, Björn Jindra, and Martin G. Moehrle. "Patenting patterns in Artificial Intelligence: Identifying national and international breeding grounds." World Patent Information 62 (2020): 101988.

Ng-Loy, W. L. (2015). IP and FTAs of Singapore: Ten years on. In C. Antons & R. M. Hilty (Eds.), *Intellectual property and free trade agreements in the Asia-Pacific region* (pp. 337–353). Springer.

Ng-Loy, W. L. (2004). The IP chapter in the US – Singapore Free Trade Agreement. Singapore Academy of Law Journal, 16(1), 42–75.